## Synchrotron Radiation at the Advanced Photon Source

The Materials Research Collaborative Access Team (MRCAT) beamline is located in the Advanced Photon Source Facility at Argonne National Laboratory. Figure 1 shows the MRCAT facility in use for oxidation studied. Proposals requesting the use of these facilities should focus on pre-irradiation examination, post-irradiation examination, or concurrent use with ongoing irradiations at ATR NSUF. Experiments conducted at MRCAT as part of this ATR NSUF proposal call will be facilitated by the Illinois Institute of Technology.

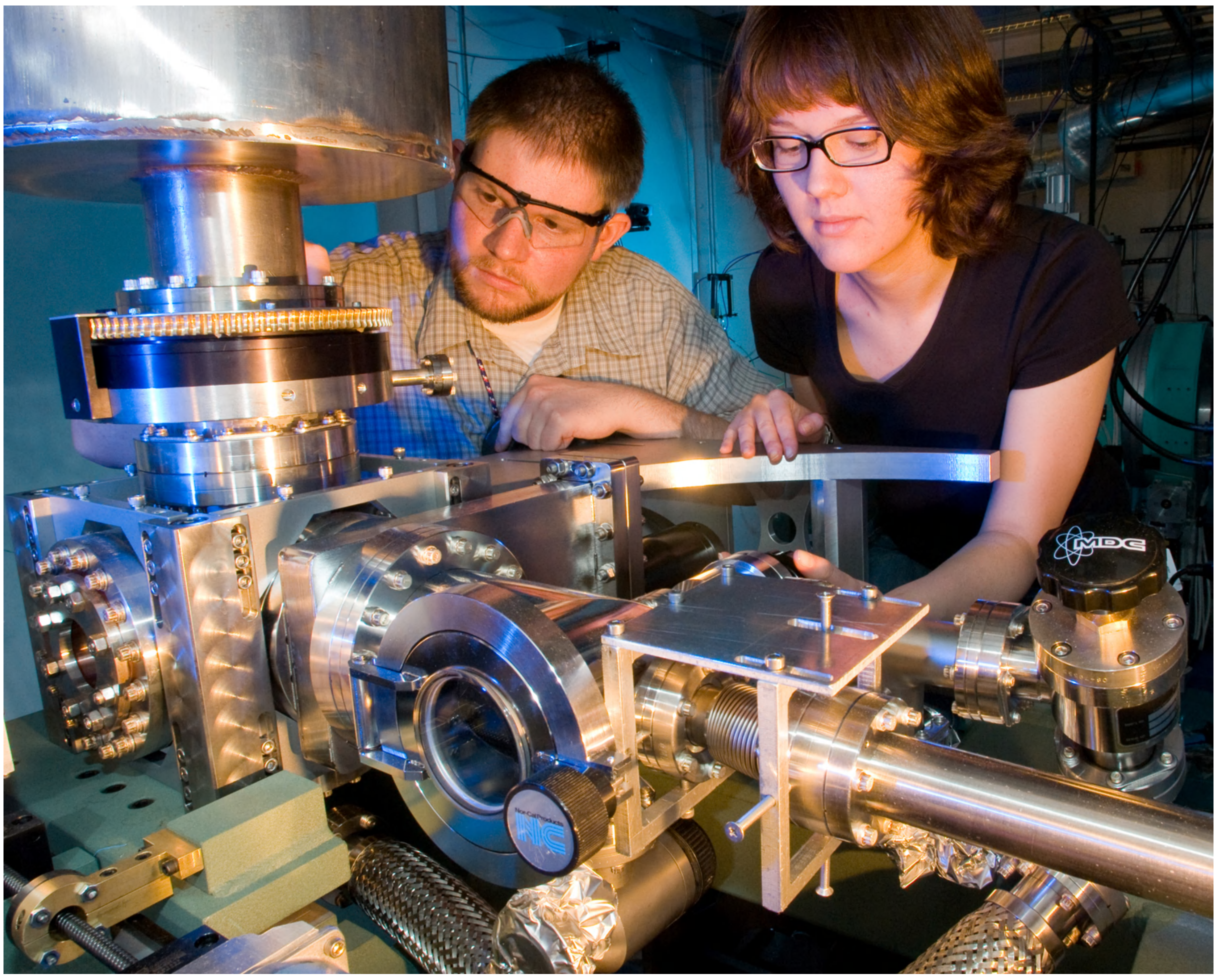


Figure 1: Graduate students are using a controlled atmosphere chamber at the MRCAT facility at the Advanced Photon Source to study surface oxidation. This system allows x-ray absorption measurements to be performed on nonradioactive samples under controlled environments from $10^{-5}$ to 760 torr. Sample temperature can be varied from 110 K to 1300 K.

Experiments that can currently be carried out at the MRCAT include x-ray diffraction (XRD), x-ray absorption (XAS), x-ray fluorescence (XRF), and 5 μm spot size fluorescence microscopy.

Other equipment currently available at MRCAT for use as part of this call includes:

- A Si (111) monochromator consisting of a cryo-cooled first crystal and a 250mm long second crystal that provides an energy range of 4.8 keV to 30 keV from the fundamental reflection. Other reflections can be utilized to obtain photon energies as high as 100 keV. The second crystal has a piezoelectric tuning actuator with a.c. feedback and a Bragg-normal motion that permits some degree of fixed-offset operation.

- A 60 cm long flat harmonic rejection mirror with Pt and Rh coatings. This mirror resides in the experimental station and may be moved vertically in or out of the beam as the experiment requires. A second float glass mirror is available for use as a steering mirror. Recently, a beam cleaner has been fabricated that allows a single harmonic to be selected. This system is necessary for diffraction experiments at high photon energies.

- An 8-circle goniometer that allows for accurate positioning of large sample chambers and detectors with respect to the incident beam. The goniometer has been mounted to a lift table of our own design which permits the two vertical axes of the goniometer to be positioned perpendicular to the beam direction as it is deflected by the mirror system or truly vertical as required by the individual experiment. The two circles that control the detector position have encoded motors that permit continuous scanning and data acquisition using the multichannel scaler described below.

- Basic microfocusing capability is available on a kinematically mounted table with a vibration isolation breadboard and positioning systems for sample, microscope, and Kirkpatrick-Baez mirrors. The minimum spot size for the current mirrors is approximately 5μm × 5μm. The system has been used for fluorescence mapping and spectroscopy experiments.

- The MRCAT sector is currently equipped with two Boyd Technology ion chambers for use spectroscopy system and 6 smaller Cornell-type ion chambers that may be mounted for either spectroscopy or on the Huber goniometer detector arm for diffraction. Three Lytle-type fluorescence detectors are also available. Data collection is through a standard instrument chain of Keithley electrometers, V-F converters and a 32 channel multichannel scaler. The multichannel scaler permits continuous of the energy and the goniometer detector motors. The goniometer detector arm can be fitted with one of two flat Si analyzer crystals and NaI scintillation detectors for high-resolution diffraction experiments.

- A 16-element solid–state detector for dilute XAFS and Fluorescence measurements.
- A bent Laue fluorescence analyzer set to work in the energy range covered by the actinide L fluorescence lines is also available. This detector is capable of easily separating close-lying fluorescence lines and is not as count rate limited as a solid–state detector. Data acquisition is handled by the MX system.

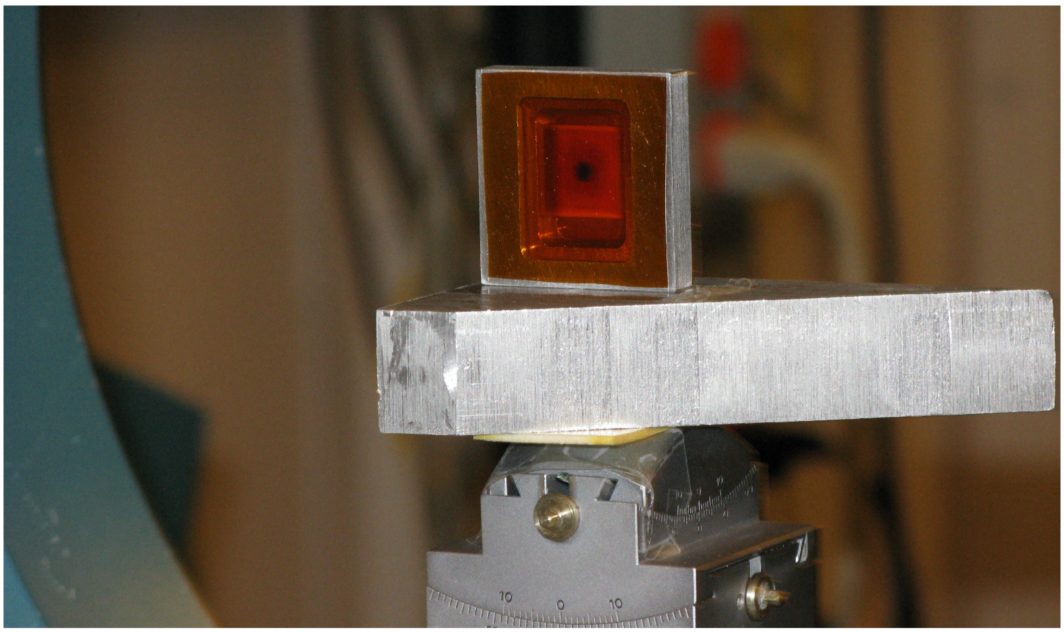

Figure 2: An irradiated stainless steel sample is mounted inside of a triple–containment cell on the MRCAT diffractometer. The sample had an activity of 20 μCi. Samples can be measured in either Bragg or Laue geometries. X–ray diffraction measurements are made using an analyzer crystal to remove background due to sample gamma emission.

The beam spot size is limited to 1 mm by 1 mm so typical samples are the size of TEM disks, 3 mm by 0.250 mm. Sample activity may not exceed 0.200 mCi for this call. All radioactive samples must be in an approved triple containment cell. Specialized equipment can often be mated to the equipment already located on the beamline. Non-radioactive samples may or may not need to be in containment depending on the hazards associated with the material. The technical contact for the use synchrotron radiation techniques for material characterization is Jeff Terry (terryj@iit.edu). He may be contacted for more details regarding APS capabilities and your proposal submission. The MRCAT website can be found at: http://mrcat.iit.edu.

## Research Areas for Experiments with Synchrotron Radiation

The research areas listed here represent promising applications of synchrotron x-ray techniques in characterizing microstructural evolution and associated physical and mechanical properties of materials under irradiation.

- Fundamental Aspects of Radiation Damage
- Phase Stability and Phase Transformation under Irradiation
- Surfaces and Grain Boundaries in Irradiated Materials
- Deformation and Fracture of Irradiated Materials
- Physics and Chemistry of Nuclear Fuels
- Nuclear Forensics
- Repository Science and Environmental Chemistry

## Technical Contact

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